

Whole Body Bone, Fat and Lean Mass in Children: Comparison of Three Ethnic Groups

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ABSTRACT We measured whole body bone, fat and lean mass, by dual-energy x-ray absorptiometry, of third-grade children in a suburban public school district adjacent to Detroit. Of 1,340 eligible children, 773 participated. Using U.S. Census categories, parents identified their children as black/African-American (57%), white (38%), or one of several other categories (5%). Some of the participants also identified with a relatively large Middle Eastern subgroup (Chaldeans). Of the 773 participants, 734 are included in this report (71 Chaldeans, 226 whites, and 437 black/African-Americans; other categories are omitted). We describe body size, body composition, and physical activity levels in the three groups.

The Chaldean and black children have significantly higher average whole body bone mineral content (BMC) than whites ($P > 0.05$), but are not different from each other. Lean mass and height are significantly greater for Chaldeans and blacks than for whites. The ratio of BMC to height was also significantly greater in Chaldeans and blacks compared with whites. Chaldeans have a significantly higher weight and fat mass than either the black or white children, and report significantly less physical activity than either the white or the black children. The higher bone mass among the Chaldean children may be partially explained by their greater body mass, but there is no readily apparent explanation for the observed ethnic differences in body size. We cannot exclude genetic or environmental factors not evaluated in this observational study.

Our unexpected finding that Chaldean children, when analyzed as a separate group, are more similar in body composition to black/African-American than to white children contributes to a growing body of literature indicating that the uncritical use of "race" categories may obscure rather than facilitate the identification of population differences. *Am J Phys Anthropol* 103:157-162, 1997. © 1997 Wiley-Liss, Inc.

It has been well-documented that there are bone mass and bone density differences between ethnic groups in the United States. The majority of these data are derived from studies of white and black adults (Trotter et al., 1960; Mayor et al., 1980; Cohn et al., 1977; Liel et al., 1988; Luckey et al., 1989; Nelson et al., 1991, 1995; Kleerekoper et al., 1994) with some information on other ethnic groups (Davis et al., 1991a,b, 1994; Tobias et

al., 1994; Szejnfeld et al., 1995; Tsunenari et al., 1995; Sugimoto et al., 1992; Reid et al., 1986). Studies in children, including our own, have also demonstrated black-white

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differences in bone mass and density from early childhood onward (Laraque et al., 1990; Li et al., 1989; Garn and Poznanski, 1987; Gilsanz et al., 1991; Thomas et al., 1991; Nelson et al., 1997). However, there are few data on bone mass among children from other ethnic groups in the United States. Likewise, there are few studies of body composition using whole-body dual-energy x-ray absorptiometry (DXA), and none reported for children from underrepresented minority groups. Our study is unique because it includes both boys and girls, as well as three race/ethnic groups.

The primary objective of the present study is to describe whole body bone mineral content (BMC), fat and lean mass in children from three ethnic groups based on the parents' classification of the child. Specifically, we compare third-grade children from a Middle Eastern ethnic group with white and black children from the same school district. The Middle Easterners identify themselves as Chaldean, a relatively large population of Iraqi Christians who are well-represented in this community (Sengstock, 1980). To our knowledge, there are no comparative biocultural data on Middle Eastern populations in the United States and, in particular, there are no such data for children.

A second aim of this study is to evaluate whether use of "racial" categories as currently defined by the U.S. Census would have obscured "ethnic" differences in biologic characteristics in our study. Other analyses of statistics based on census data have shown that they do not always provide accurate information on differences in biologic variables (Hahn, 1992; Hahn et al., 1992; Hahn and Stroup, 1994; McKenney and Bennett, 1994; U.S. Department of Health and Human Services, 1993). Relevant to the present study, Middle Eastern populations are included in the category "white" (OMB Statistical Policy Directive 15, 1978). Therefore, we investigate if, in fact, the Chaldean children are more similar, in body size and composition, to the whites than to the black/African-Americans enrolled in our study.

METHODS

Participants were recruited over two consecutive years from all third grade classes in the Southfield Public Schools district, adjacent to Detroit. Of 1,340 potentially eligible participants, 1,180 (88%) completed a telephone survey; of these, 773 children came to our research center for a baseline bone mass measurement. Average age of the participants at the time of their study visit was 8.9 ± 0.59 years, and all children were prepubertal based on questionnaire data (including menarcheal status for the girls and genitalia size/pubertal hair for boys). Based on categories used by the U.S. Census, 57% of the children were identified by their parents as black, 38% as white, and 5% other categories. Ethnic composition among study participants mirrors that of the telephone responders, as well as figures from the U.S. Census for the City of Southfield (U.S. Bureau of the Census, 1990). Knowing that a large Middle Eastern population resides in Southfield, we inquired about ethnicity separately from "race" in order to characterize the Chaldean subgroup. Based on this open-ended question, 71 families stated that they were Chaldean. Of the five census categories for race, all but one of the Chaldean families chose white; one chose Asian; and none chose black, Native American/American Indian, or Alaskan Native/Eskimo/Aleut.

During the study visit, height was measured with a Harpenden stadiometer and weight with a Seca digital scale while participants were in street clothes without shoes. Bone mass and body composition were measured with a Hologic 1000W bone densitometer, which is based on dual-energy x-ray absorption (DXA) (Slosman et al., 1992). Whole body fat and lean mass, as well as bone mineral content (BMC), are reported in grams. The ratio of BMC to height (g/cm) is also reported in order to minimize effects of any differences in body size between groups. Physical activity, estimated in hours per week spent on specific activities, was assessed by questionnaire. This was done separately for summer and school months. Later, responses were weighted and pooled for an estimate of the total annual activity hours.

TABLE 1. Ethnic and sex comparisons of body size, bone, fat and lean mass in children age 8.9 ± 0.6 years¹

	Height (cm)	Weight (kg)	BMC (g)	Fat mass (g)	Lean mass (g)	BMC/Ht (g/cm)
White (n = 226)	134.1 \pm 6.7 ^{2,5}	32.3 \pm 7.5 ³	859.4 \pm 222.6 ^{2,3}	7493.9 \pm 3871.3 ³	23271.5 \pm 4029.0 ^{2,3}	6.37 \pm 1.42 ^{2,3}
Boys (n = 124)	134.8 \pm 5.5	32.3 \pm 6.7	855.0 \pm 190.6	6887.1 \pm 3425.9	23860.2 \pm 3504.2	6.32 \pm 1.25
Girls (n = 102)	133.2 \pm 7.8	32.3 \pm 8.4	864.7 \pm 257.1	8231.7 \pm 4253.4	22555.7 \pm 4501.7	6.43 \pm 1.61
P (δ vs. φ)	0.09	0.98	0.75	0.01	0.02	0.57
Black (n = 437)	136.0 \pm 7.2 ²	33.8 \pm 8.7 ⁴	963.5 \pm 262.6 ²	7590.4 \pm 4494.3 ⁴	24541.0 \pm 4609.7 ²	7.03 \pm 1.65 ²
Boys (n = 210)	136.1 \pm 7.0	33.5 \pm 8.6	961.0 \pm 259.3	6688.6 \pm 4142.0	25046.6 \pm 4622.7	7.00 \pm 1.60
Girls (n = 227)	135.9 \pm 7.3	34.2 \pm 8.8	965.8 \pm 266.1	8424.7 \pm 4652.6	24073.3 \pm 4558.0	7.06 \pm 1.69
P (δ vs. φ)	0.71	0.40	0.85	0.0000	0.03	0.74
Chaldean (n = 71)	135.6 \pm 7.2 ⁵	36.1 \pm 10.7 ^{3,4}	951.8 \pm 288.0 ³	9804.2 \pm 5983.0 ^{3,4}	24602.6 \pm 5105.2 ³	6.95 \pm 1.79 ³
Boys (n = 40)	136.6 \pm 6.7	37.1 \pm 10.7	971.9 \pm 280.3	9416.6 \pm 5318.1	25936.6 \pm 5196.8	7.05 \pm 1.73
Girls (n = 31)	134.3 \pm 7.8	34.9 \pm 10.7	925.8 \pm 300.2	10304.4 \pm 6804.3	22881.4 \pm 4502.3	6.82 \pm 1.89
P (δ vs. φ)	0.19	0.39	0.51	0.54	0.01	0.59

¹ For all measurements mean \pm SD are reported.² Significant for white vs. black ($P \leq 0.05$).³ Significant for white vs. Chaldean ($P \leq 0.05$).⁴ Significant for black vs. Chaldean ($P \leq 0.05$).⁵ Significant for white vs. Chaldean ($0.05 < P \leq 0.10$).

There were 22 physical activity categories, ranging from general outdoor play to individual and team sports, and including brisk walking, dancing, and other physical activities. Two categories list nonphysical or sedentary activities including reading, homework, crafts, television watching, and video/computer games. We utilize these data not for accurate estimates of actual time spent on activities over a year, but for comparisons of mean levels of activities between groups, assuming internal consistency.

Statistical analyses were done with SAS software system (SAS Institute Inc., Cary, NC). We used *t*-tests to evaluate sex differences within ethnic groups, and analysis of variance (ANOVA) to test for ethnic differences among the three ethnic groups. Post-hoc pairwise testing was done with Duncan's multiple range test (Cody and Smith, 1991) on all of the variables that were found to be significant by ANOVA testing. Based on the SAS software used for statistical analyses, alpha was set at 0.05 for the post-hoc testing; the same tests were repeated with alpha set at 0.10, and both significance levels are reported. Multiple linear regression analysis was performed with BMC as the dependent variable and ethnic group, annual activity hours, and the interaction of ethnicity/activity hours, as the independent variables. To be certain that age in our prepubertal sample of third-graders was not influencing the outcomes of our tests, we adjusted the data by age (by

analysis of covariance) and repeated our analyses.

RESULTS

Results of the ethnic comparisons (Table 1) show that Chaldean children have a significantly higher BMC than whites and are not different from blacks. The results are the same for BMC/height. Chaldean children are significantly heavier than the white children, and have a significantly greater fat mass than either the white or black children. Chaldeans and blacks have significantly greater lean mass than whites but they are not significantly different from each other. The black children are significantly taller than the white children.

Analyses of activity data indicate that the Chaldean children are significantly less active than either white or black children. They also have a significantly greater number of sedentary activity hours (Table 2). However, in a multiple linear regression analysis with BMC as the dependent variable, neither activity hours nor the interaction between ethnicity and activity hours enters the model significantly ($P = 0.82$ and $P = 0.48$, respectively).

Sex differences within ethnic groups were also assessed (Table 1). Among white and black children, there are significant sex differences in total fat mass (girls > boys). In all three ethnic groups, boys have a significantly greater lean mass than girls. There are no significant sex differences in body size

TABLE 2. Ethnic and sex comparisons of physical activity and sedentary activity time¹

	Activity time (hr/yr)	<i>P</i>	Non-active time (hr/yr)	<i>P</i>
White (n = 227)	1238.6 ± 675.3		943.3 ± 498.8	
Boys (n = 125)	1304.9 ± 711.9		946.0 ± 510.9	
Girls (n = 102)	1137.5 ± 623.7		954.2 ± 498.5	
<i>P</i> (♂ vs. ♀)		0.09		0.89
Black (n = 436)	1117.4 ± 783.7		1029.2 ± 564.5	
Boys (n = 209)	1253.1 ± 911.6		964.0 ± 538.5	
Girls (n = 227)	985.8 ± 617.0		1085.2 ± 580.4	
<i>P</i> (♂ vs. ♀)		0.0004		0.03
Chaldean (n = 64)	936.4 ± 582.6 ²		1189.2 ± 502.6 ²	
Boys (n = 35)	1051.7 ± 577.7		1078.6 ± 406.1	
Girls (n = 29)	797.2 ± 567.3		1322.7 ± 578.2	
<i>P</i> (♂ vs. ♀)		0.08		0.05

¹ For all measurements mean ± SD are reported.² Significant for Chaldean vs. white and black (*P* ≤ 0.05).

(height and weight) or bone mass (BMC and BMC/height) in any group. However, the boys tend to be taller than the girls in the white and Chaldean groups.

There are significant sex differences in physical activity and sedentary time (Table 2). In all three ethnic groups boys report spending more active hours than girls. Among both blacks and Chaldeans, but not whites, girls report significantly more time spent on sedentary activities.

The age-adjusted analyses (mean age = 8.9 ± 0.59 years) produced no differences from the results obtained with age-unadjusted data. For this reason, the information in Table 1 is not broken down by age.

DISCUSSION

It has been well-documented that categories of "race" are not based on biology but on demographic characteristics. However, it is expected that members of the same category will be more similar to each other than to members of other categories. Since Chaldeans, as Middle Easterners, would be included in the white category, the a priori expectation was that the Chaldean children would be more similar to non-Chaldean whites than to blacks. This was not borne out by our data. Our study contributes to the growing body of literature from many disciplines on the problems inherent in the use of such categories as a taxonomic tool in biomedical research (Crews and Bindon, 1991; Cheung, 1993; Cooper, 1994; Senior and Bhopal, 1994).

The higher bone mass among Chaldean compared with white children may be par-

tially explained by their greater weight, fat, and lean mass. This model is based on the well-known association between a higher bone mass and larger body size as observed in studies of white and black adults (Cohn et al., 1977; Doyle et al., 1970; Nelson et al., 1988; Pruzansky et al., 1989). One of the explanations for this relationship is that load bearing and mechanical forces have a salutary effect on bone (Doyle et al., 1970; Cohn et al., 1977). However, there was no significant correlation in our study between physical activity level and BMC. One could speculate that there may be significant ethnic differences in diet that would affect growth and, by logical extension, body mass and its components.

The Chaldean community in Southfield represents a relatively recent immigrant group (Sengstock, 1980, 1982), although most of the Chaldean children (89%) participating in our study were born in the Detroit metropolitan area, with an additional 4% born elsewhere in the United States. Given the ethnographic description of Chaldean social structure as patriarchal with highly differentiated sex roles (Sengstock, 1982), we expected there to be significant sex differences in some of the variables. Our results, indicating that Chaldean boys are more active than girls, that girls report more time spent on sedentary activities, and that boys have a greater lean mass than girls, lend support to our expectations for this group. Although some of these sex differences were also significant in the white and black groups, the percentage difference between the sexes was consistently higher among the

Chaldeans (25% more sedentary hours than white and 16% more than black children) (Table 2).

These data also suggest that factors other than physical activity level, as assessed in this study, contribute to the association between a higher bone mass and larger body size (including the fat and lean components). That is, the white children report the highest level of physical activity but have the lowest BMC, fat and lean mass, which is counterintuitive given that physical activity is assumed to have a positive effect on body mass. Within ethnic groups, boys report more physical activity hours but do not have significantly higher bone mass than girls. Studies that include dietary components, other environmental variables, and genetic influences will be necessary to help answer the underlying question of why certain ethnic groups have a greater skeletal mass, accompanied by a greater body mass, throughout life.

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